

## **REMARKS**

Claims 12-26 are pending in the application. Claims 12-26 were rejected. The following remarks are believed to be fully responsive to the Final Office Action, and reconsideration of the rejection is respectfully requested.

### **CLAIM REJECTION – 35 U.S.C. § 112**

Claims 12-26 stand rejected under 35 U.S.C. § 112, first paragraph, on the grounds that the specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make the invention commensurate in scope with these claims, for the reason set forth on page 2 of the Final Office Action.

The Examiner pointed out that the specification, while being enabling for forming a barrier layer along a stepped portion over the surface of an interdielectric layer having a recessed region, and forming a copper seed layer on the barrier layer, does not reasonably provide enablement for exposing the barrier layer until exposing the surface of the interdielectric layer by chemical mechanical polishing using a solution comprising an oxidizing agent, a pH controlling agent, a chelate reagent, and deionized water so that the copper seed layer remains only within the recessed region. The Examiner stated that “essential information is missing from the specification about how a person of ordinary skill in the art could develop the step of ‘exposing the barrier layer until exposing the surface of the interdielectric layer by chemical mechanical polishing so the copper seed layer remains only within the recessed region.’”

Claim 12 recites:

12. A method of manufacturing a copper metal interconnection layer comprising the step of:
  - (a) forming a barrier layer along a stepped portion over the surface of an interdielectric layer having a recessed region;

- (b) forming a copper seed layer on the barrier layer; and
- (c) exposing the barrier layer until exposing the surface of the interdielectric layer by chemical mechanical polishing using a solution comprising an oxidizing agent, a PH controlling agent, a chelate reagent, and deionized water so that the copper seed layer remains only within the recessed region.

The Examiner's attention is respectfully directed to, for example, the specification, on page 6, wherein the elements used and removal rate of various layers by CMP according to a preferred embodiment of the invention are provided. For example, removal rate by CMP using copper, Ta, TaN, and PE-TEOS are described with the removal rate for copper by CMP being about 1000Å, removal rates for Ta and TaN are about 200Å to about 500Å respectively, and removal rate for PE-TEOS is lower than about 50Å (lines 8-13). After depositing a barrier layer, which may be Ta or TaN and a copper seed layer on an interdielectric layer (which may be PE-TEOS as known in the art) having a recessed region, the step of "exposing the barrier until exposing the surface of the interdielectric layer so that the copper layer remains only within the recessed region" is performed (page 6, line 20 to page 7, line 5).

With the above teaching, one skilled in the art appreciates that at the initial stage of CMP, removal rate is fast since the copper seed layer whose removal rate is the fastest is polished. Once the barrier is exposed by removing the copper seed layer, removal rate slows down since Ta or TaN removal rates are slower than that of the copper seed layer. Likewise, one can detect the end point of CMP (when to stop CMP) since once the interdielectric layer is exposed by removing the barrier layer, removal rate further slowed since PE-TEOS removal rate is the slowest.

The step of "exposing the barrier layer" is further provided on page 7, lines 9-10: "CMP is performed using the solution of the present invention to polish and remove the

upper copper layer...and the surface of the barrier 24 except in the recessed regions 22 is exposed.”

The step of “exposing the surface of the interdielectric layer by chemical mechanical polishing” is provided on page 7, lines 26-28: “...portions of the barrier layer 24 projecting above the surface of the interdielectric layer 20 are removed by second CMP process....”

A conventional Chemical Mechanical Polishing (CMP) process is described on page 1, lines 23-29: “Generally, the CMP process applies combining chemical effects of chemical solutions with mechanical effects of a polisher and polishing particles. When a wafer surface contacts a pad, a slurry for CMP process flows into a minute gap between the contact surfaces of the wafer and the pad, so that a mechanical operation is performed by abrasive particles within the slurry and bumps on the surface of the pad, and a chemical removing operation is performed by a chemical component within the slurry.”

Another direction shown to make the invention is provided on page 5, lines 3-11: “according to a preferred embodiment of the present invention, a solution for CMP relates to a solution used for manufacturing a copper (Cu) metal interconnection, and more particularly, to a solution for CMP without an abrasive.... However, the solution according to a preferred embodiment of the present invention does not include the abrasive, thus avoiding the above problems caused by abrasive.”

Lastly, the step of “copper seed layer remains only within the recessed region” is provided on page 7, lines 24-30, of the specification and Fig. 5 of the present invention. The specification states that portions of the copper layer, portions of the trench copper seed layer, and portions of the barrier layer are removed by CMP process, and then, a

planarized barrier layer and a planarized trench copper seed layer are formed. In addition, Fig. 5 illustrates that the planarized trench copper seed layer 26b remains only within the recessed region 22.

Therefore, the specification in the present invention has provided sufficient direction to a skilled artisan to make invention without undue experimentation.

Examiner also pointed out that “the specification does not disclose at least one method for making and using the claimed invention that bears a reasonable correlation to the entire scope of the claim.” However, the specification of the present invention discloses the steps of: forming a barrier layer; forming a copper seed layer; and exposing the barrier layer by CMP using a solution without abrasive (see page 6, line 28 to page 7, line 18).

Applicants respectfully submit that the specification in the invention has provided sufficient direction to a skilled artisan to make the claimed invention without undue experimentation. Applicants, therefore, respectfully submit that the rejection under 35 U.S.C. § 112, first paragraph, be withdrawn.

## CONCLUSION

In light of the above remarks, Applicants respectfully submit that all claims 12-26 of the present application are in condition for allowance. Accordingly, Applicants respectfully request that Examiner pass this case to issue. If Examiner believes that personal contact with Applicant's representative would expedite prosecution of the application, she is invited to call the undersigned at her convenience.

Respectfully submitted,

By:

  
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